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ABSTRACT

A study was conducted at a large suburban community college in Northern Illinois to examine the nature of the relationship between student self-perception/attitude variables and final course grades in four levels of mathematics: elementary algebra, intermediate algebra, college algebra, and technical mathematics. Findings, based on data obtained from 89 elementary algebra students, 70 intermediate algebra students, 83 college algebra students, and 67 technical mathematics students, included the following: (1) 65% of the students had previously taken a similar course; (2) 55% indicated a neutral or negative attitude toward math, with college algebra and technical math students exhibiting more positive attitudes; (3) more than 70% of the students rated their math ability as average or poor, with college algebra and technical math students rating themselves higher; (4) 65% stated that they were taking the course because it was a prerequisite or required for a major; (5) about 50% reported taking their last math courses 2 or more years previously; (6) 65% of the students felt they would perform at an above average level or higher in the course, and the final course grade average was slightly above C; and (7) the higher the course level, the more positively the students rated their confidence, the lower their anxiety level, and the more positively the students perceived the teacher's attitude to be. The study report includes a stepwise regression analysis of data. (EJV)

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ATTITUDES AND STUDENT PERCEPTIONS:

Their Measure and Relationship to Performance in Elementary Algebra,
Intermediate Algebra, College Algebra and Technical Mathematics.

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BACKGROUND

For some time, the attitudes and self-perceptions of students toward mathematics have attracted the attention of researchers. Aiken (1976) surveyed the literature and found a large volume of material in this area. He also noted that when attitude scores are used as predictors of achievement, generally low positive correlations result. Shavelson, Hubner and Stanton (1976) reported on an extensive study of self-concept. They concluded that self-concept is important as an educational outcome and as a moderator of achievement. As a result of a meta-analytic study, Hansford and Hattie (1982) established an average relationship between self-perception and performance/achievement. They found that it consisted of a low positive correlation in the range of .21 to .26. But, they also found that this average could be modified by other variables.

Poffenberger and Norton (1959) studied the formation of attitudes toward mathematics. They reported that parental attitudes and expectations differentiated the positive attitude group from the negative group. They also found that in the positive attitude group, there was a relationship between liking the teacher and liking the course.

A study by Frary and Ling (1983) seemed to indicate that mathematics anxiety may be a global construct independent of personality variables. Also, they concluded that mathematics anxiety could be superficial and responds to persuasion and desensitization. Some attempts have been made to link attitudes toward mathematics and self-perceptions with performance. Edwards (1972) reported that high school grade point average, precourse mathematics achievement, mathematics interest, and attitude were the best predictors of performance. Stones, Beckmann, and

Stephens (1980) concluded that attitude was a factor useful in explaining differences in competency. Eldersveld (1983) found that numerical skills, age, self-assessment of attitude toward mathematics, and instructional method were among the better predictors of success in developmental mathematics. However, Bleyer (1980) reported that attitude was not significantly correlated with learning. Finally, Hogrebe and Dwinell (1983) found that self-perception variables are related to performance, but that academic variables are able to account for considerably more variance in first quarter grade point average than self-perception variables. These and other studies clearly indicate that, in general, cognitive/academic variables are better predictors of performance than noncognitive variables.

PURPOSE

The purpose of this study was to examine the nature of the relationship between student self-perception/attitude variables and final grade in elementary algebra, intermediate algebra, college algebra and technical mathematics. In addition, the interrelationships of some variables were examined.

METHOD

Students from a large suburban community college in Northern Illinois participated in this study. Data were obtained from subjects in four levels of mathematics courses: elementary algebra ($N = 89$), intermediate algebra ($N = 70$), college algebra ($N = 83$) and technical mathematics ($N = 67$).

Table 1 describes the variables selected for this study and the method used to obtain the data. Data were obtained early in the quarter of registration. Frequency data were obtained to study population

characteristics. Pearson correlations were computed to analyze the interrelationships between the variables. As a result, several high correlations between variables were noted. After analysis of the matrix of Pearson correlations in Tables 3, 4, 5, and 6, the questionnaire and scale items, the variables SEFCON and SEFATT were removed from further study. These variables were covered elsewhere, and the removal minimized problems with collinearity in the regression analysis.

Finally, a regression analysis was used to determine the relationship between the remaining independent variables and the dependent variable, final grade (FINGRD) in the course.

RESULTS

Descriptive Data

Table 2 contains means and standard deviations for each variable and each subgroup. More than 65% of the subjects reported they had taken a similar course before (PRGRD). When asked to rate their attitude (SEFATT) toward mathematics, nearly 55% indicated a neutral or negative attitude with college algebra and technical mathematics students exhibiting more positive attitudes. These data are consistent with the subjects' self-rating of their ability (SEFABL). More than 70% rated their ability to be average or poor. Again, college algebra and technical mathematics students rated themselves higher.

When asked to indicate why they were taking the course (RESCRS), more than 65% exhibited strong reasons such as a prerequisite course or required for a major. The responses were reasonably uniform across subgroups. Subjects were also asked to report on their previous mathematics experiences (SEFEXP). More than half reported they had taken algebra and geometry. As expected, college algebra students reported

taking more mathematics courses, and elementary algebra students less courses. The time interval since the last mathematics course was determined by (TIMCRS). About 50% reported taking their last mathematics course two or more years previous. The data revealed that college algebra and intermediate algebra students took a previous mathematics course more recently than the elementary algebra and technical mathematics students.

Subjects were also asked to comment on their expectations (SEFEXPT) for the mathematics course. More than 65% indicated they thought they would perform at an above average level or higher. These data were quite uniform across subgroups. After final grades were obtained from grade reports, an average was computed based on a four point scale (A = 4, B = 3, C = 2, D = 1, F or W = 0). The subjects overall average was slightly above C. These results were uniform across subgroups.

Finally, three Fennema-Sherman Mathematics Scales were used to assess self-confidence (SEFCON), mathematics anxiety (MATANX), and the students' perception of the teacher's attitude toward him/her (TCHSTD). In each case, the higher level of mathematics, the more positively the student rated his/her confidence, the lower the anxiety level, and the more positively the student perceived the teacher's attitude to be. The mean age for the population was 24.2 years and 59% were males and 41% were females.

Correlation Data

Tables 3, 4, 5, and 6 contain Pearson Correlation coefficients for each of the subgroups in the study. Several reasonably strong intercorrelations resulted. Of particular interest are the following: (1) SEFCON and MATANX - .75 to .84, (2) SEFCON and SEFABL - .65 to .71,

(3) SEFCON and SEFATT - .69 to .79, (4) MATANX and SEFATT - .69 to .74, (5) MATANX and SEFABL - .51 to .64, and (6) SEFABL and SEFATT - .36 to .67. These correlations indicated the existence of a relationship between these variables. Each questionnaire item was examined as well as the context of the 12 scaled items. Some redundancy was found to be present. As a result, SEFCON and SEFATT were removed from the set of independent variables prior to conducting the regression analysis.

Regression Analysis

A stepwise regression analysis was conducted on each of the subgroups. In each case PRGRD, SEFABL, RESCRS, SEFEXP, TIMCRS, SEFEXPT, SEFEMP, SEX, TCHSTD, MATANX, and AGE were used as independent variables and FINGRD was the dependent variable. Several regression analyses were performed using the stepwise and forward methods of the NEW REGRESSION subroutine of the Statistical Package for Social Sciences (1981). All data obtained regardless of method were the same as reported in Tables 7, 8, 9, and 10.

For the elementary algebra subjects ($N = 89$), the regression data are shown in Table 7. For the variables entered in the first six steps R-squared increased, the adjusted R-squared increased, and the standard error of R-squared decreased. For these variables R-squared was .195 indicating that about 19 percent of the variance in FINGRD was explained by SEFEXPT, TIMCRS, SEX, SEFABL, AGE, and SEFEMP operating jointly. However, it should be noted that SEFABL and SEFEXPT have a Pearson correlation coefficient of .53 and the change in F was not significant at a reasonable level. Also, the change in R-squared during the last three steps is quite small. Hence, a more appropriate model for explaining variance in FINGRD would be to use the variables in the first three

steps. Collectively, SEFEXPT, TIMCRS, and SEX accounted for about 14 percent of the variance in FINGRD. The standard error of R-squared using these variables was 1.24 indicating that on the average predicted FINGRD scores deviated from the actual scores by 1.24 on a four point grading scale. Finally the Pearson correlations for three predictor variables are worthy of note. The correlations indicated that: (1) the higher a subject's expectation (SEFEXPT), the higher the FINGRD, (2) the longer the interval since the last mathematics course (TIMCRS), the higher the FINGRD, and (3) the higher the FINGRD, the more likely the subject was a male.

For the intermediate algebra subjects ($N = 70$), the regression data are shown in Table 8. For the variables entered in the first four steps R-squared increased, the adjusted R-squared decreased, and the standard error of R-squared decreased. For these variables R-squared was .204 indicating that about 20 percent of the variance in FINGRD was explained by AGE, SEFABL, SEFEXP, and PRGRD operating jointly. An examination of the intercorrelations of these variables yielded no evidence of redundancy. Subsequent changes in R-squared were small and the values of the standard error of R-squared and the adjusted R-squared mitigated against the inclusion of more than four variables. The standard error of R-squared was .99 using AGE, SEFABL, SEFEXP, and PRGRD as independent variables indicating that on the average predicted FINGRD scores deviated from the actual scores by .99 on a four point scale. Finally, the Pearson correlations for the four predictor variables indicated that: (1) the older the students, the higher the FINGRD, (2) the higher the self-rating of ability, (SEFABL), the higher the FINGRD, (3) the more

mathematics taken previously (SEFEXP), the higher the FINGRD, and (4) the more a student tended to have taken this course before (PRGRD), the lower the FINGRD.

For the technical mathematics subjects ($N = 67$), the regression data are shown in Table 9. For the variables entered during the first four steps R-squared increased, the adjusted R-squared decreased, and the standard error of R-squared decreased. For these variables, R-squared was .128 indicating that about 12 percent of the variance in FINGRD was explained by AGE, SEFEXPT, SEFEXP, and SEFEMP operating jointly. An examination of the intercorrelations of these variables yielded no evidence of redundancy. Subsequent changes in R-squared were small, and the changes in the standard error of R-squared and the adjusted R-squared mitigated against the inclusion of more than the four variables. The standard error of R-squared was 1.59 using AGE, SEFEXPT, SEFEXP, and SEFEMP as independent variables indicating that on the average predicted FINGRD scores deviated from the actual scores by 1.59 on a four point scale. Finally, the Pearson correlations for the four predictor variables indicated that: (1) the older the students, the higher the FINGRD, (2) the higher the subjects' expectations (SEFEXPT), the higher the FINGRD, (3) the less mathematics taken recently (SEFEXP), the higher the FINGRD, and (4) the more hours a student is employed (SEFEMP), the higher the FINGRD.

For the college algebra subjects ($N = 83$), the regression data are shown in Table 10. For the variables entered during the first four steps R-squared increased, the adjusted R-squared increased, and the standard error of R-squared decreased. For these variables R-squared was .312 indicating that about 31 percent of the variance in FINGRD was explained

by SEFEXPT, TIMCRS, MATANX, and SEX operating jointly. An examination of the intercorrelations of the variables yielded no evidence of redundancy. Subsequent changes in R-squared were small and the values of the standard error of R-squared and the adjusted R-squared mitigated against the inclusion of more than four variables. The standard error of R-squared was .97 using SEFEXPT, TIMCRS, MATANX, and SEX as independent variables indicating that on the average, predicted FINGRD scores deviated from the actual scores by .97 on a four point scale. Finally, the Pearson correlations for the four predictor variables indicated that: (1) the higher the expectation of the student (SEFEXPT), the higher the FINGRD, (2) the longer the interval since the last mathematics course (TIMCRS), the higher the FINGRD, (3) the lower the level of mathematics anxiety (MATANX), the higher the FINGRD, and (4) the higher the FINGRD, the more likely the student was a female.

DISCUSSION

The purpose of this study was to examine the nature of the relationship between student self-perception/attitude variables and final grades in elementary algebra, intermediate algebra, college algebra and technical mathematics. For each subgroup, regression analysis was used to identify variables related to final grades. In each subgroup a select group of variables was identified as collectively accounting for variance in final grade. The percent of variance ranged from 14 percent in the elementary algebra group to more than 30 percent in the college algebra group. These results are consistent with results obtained by other studies (Edwards, 1972; Eldersveld, 1983; Hoglebe, 1983). However, it should be noted that this study was able to explain higher levels of variance using only noncognitive variables. The aforementioned studies

used cognitive variables in addition to noncognitive variables. The addition, of cognitive variables to this study should be able to raise the level of explained variance in final grade (FINGRD).

The differences in the sets of identified predictor variables between subgroups should also be noted. Thus, if noncognitive variables are to be used as predictors of performance or as part of a placement testing program, the variables need to be chosen to fit the subgroup being tested. If one instrument is to be used for a large span of mathematics courses, variables must be selected to fit all of the subgroups. This study seemed to indicate that the list of noncognitive variables should include: SEFEXPT, TIMCRS, SEX, AGE, SEFABL, SEFXP, PRGRD, SEFEMP, and MATANX. Furthermore, it should also be noted that SEX, PRGRD, SEFEMP and MATANX accounted individually for less than 3 percent of the variance in FINGRD, or appeared in a predictor list only once. Specifically, MATANX, SEFEMP, and PRGRD are candidates for deletion. More research is needed to determine an optimum list of noncognitive predictor variables. Finally, if testing time is a consideration, MATANX, a twelve item list should be deleted.

While the sets of predictor variables differed between subgroups, it should also be noted that SEFEXPT, the subjects' self-rating of expected performance, placed high on the list for three of the four subgroups. This result is consistent with the results of others (Hansford and Hattie, 1982; Haynes and Johnson, 1983) and points to the importance of reinforcing students' expectation of their performance, thereby possibly influencing their performance. Of particular interest, is that the scaled variables used to assess MATANX and TCHSTD rarely occurred in the predictor lists, and when MATANX did occur with the college algebra

subgroup, it only added about 2 percent of the variance in FINGRD. A possible explanation is that the three scales (SEFCON, MATANX, TCHSTD) simply are not useful for explaining variances in final course grades or that the scales need to be revised to be more applicable to a community college population. Another possible interpretation is that MATANX is a learned response that results after exposure to several mathematics courses. Thus, the construct is not evident until the college algebra level.

It should also be noted that for each subgroup the standard error for R-squared ranged from 1.56 to .97. On a four point scale, this means that the identified variables accounted for enough variance to predict final grades in the range of one and one half grade to one grade. This result should be interpreted in the context of how much variance was explained and the size of the sample. Conclusions should be drawn cautiously.

The results of this study should be interpreted in light of the following limitations. First, the variable TIMCRS appeared twice as a predictor variable, and the data for PRGRD indicated the more than 68 percent of the subjects had taken the course before. Each time TIMCRS appeared as a predictor variable, the Pearson correlation data indicated that the longer the time interval since the last mathematics course, the higher the FINGRD. Or, conversely the shorter the time interval since the last mathematics, the lower the FINGRD. Also, data on PRGRD indicated that more than 65% of the subjects in each subgroup reported they had taken the course before. These statistical data, except for the elementary algebra and technical mathematics subgroups are difficult to relate to experience and reality. This may be an indication of

measurement problems. However, there is a possible explanation for this apparent anomaly. If the data on PRGRD are accurate, they indicated that a substantial number of subjects (in excess of 65 percent) are repeating these courses. Most likely, these students have done poorly and are re-taking the course to improve their grade. They may have taken the courses the previous quarter. In a community college setting, these students may tend to be less able and could perform poorly again. The predominance of this type of student tended to lower the FINGRD. Nevertheless, caution should be used in the interpretation of these results.

Second, care should be used in interpreting the results of this study since many of the variables in the subgroup predictor lists have rather low correlations with FINGRD. However, these results are consistent with studies cited earlier. Also, for each subgroup conclusions should be drawn conservatively and in light of the sample size.

Finally, this study raises several questions which provide evidence for more research in this area and the need for replication especially in the context of the renewed interest in placement, diagnosis, and proficiency testing. Why does the amount of variance vary so much between groups? How much more variance can be explained with the addition of cognitive variables? Is the final grade earned in a course the optimum dependent variable? Can more variables be identified which could increase the amount of explained variance in FINGRD?

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Table 1
Key To Variable Names

PRGRD	- Subjects' Self Report If They Had Course Before and Grade Earned. A High Score Indicates Having Course Before With High Grade, and A Low Score Indicates Not Having Course Before.
*SEFATT	- Subjects' Self Assessment of Attitude Toward Mathematics. High Score Indicates Very Positive, and Low Score Indicates Negative Attitude.
SEFABL	- Subjects' Self Assessment of Their Mathematics Ability. High Score Indicates Superior Ability, and A Low Score Indicates Poor Ability.
RESCRS	- Subjects' Self Assessment of Their Reason For Taking Mathematics Course. High Score Indicates Required or Pre-requisite, and A Low Score Indicates Lack of Certainty.
SEFEXP	- Subjects' Self Report of Their Mathematics Experience. High Score Indicates No Algebra, and A Low Score Indicates Two or More Years of Math in Addition to Algebra.
TIMCRS	- Subjects' Self Report of Elapsed Time Since Last Math Course. High Score Indicates A Year or Less and A Low Score Four or More Years.
SEFEXPT	- Subjects' Self Assessment of How Well They Will Do in the Course. A High Score Indicates Subject Expects A High Level of Performance, and A Low Score Indicates A Low Level of Performance.
SEFEMP	- Subjects' Self Report of Their Employment Plans While Taking This Course. A High Score Indicates Little or No Work, and A Low Score 30 or More Hours of Employment per Week.
SEX	- Subjects' Response to the Categories: Male, Female. Females Were Coded 1 and Males 0.
*SEFCON	- A Score Obtained from Subjects' Responses to the 12 Items of the Fennema-Sherman <u>Confidence in Learning Mathematics Scale</u> . The Higher the Score, the Greater the Confidence Level of the Subject.
TCHSTD	- A Score Obtained from Subjects' Responses to the 12 Items of the Fennema-Sherman <u>Teacher Scale</u> . The Higher the Score, the More Positive the Subjects Perceive the Attitude of the Teacher is Towards the Subject.
MATANX	- A Score Obtained from Subjects' Responses to the 12 Items of the Fennema-Sherman <u>Mathematics Anxiety Scale</u> . The Higher the Score, the Lower the Anxiety Level.
AGE	- Subjects' Response When Asked to State Chronological Age.
FINGRD	- The Final Course Grade As Obtained from Subjects' Records.

*Deleted from Regression Analysis. See Text of Paper for Explanation.

Table 2

Multiple Regression Data For Elementary Algebra Subjects

STEP	PEARSON R	MULT R	R SQ	ADJ R SQ	CHANGE R SQ	F CHANGE	SIGNIF. CHANGE	SE R SQ	B COEFF.*	SE B	BETA	VARIABLE NAME
1	.23	.233	.054	.043	.054	4.99	.028	1.291	.464	.185	.329	SEFEXPT
2	-.23	.334	.112	.091	.057	5.55	.021	1.259	-.167	.097	-.208	TIMCRS
3	-.13	.379	.144	.114	.032	3.19	.078	1.243	-.724	.312	-.275	SEX
4	.05	.400	.160	.120	.016	1.61	.209	1.239	-.328	.258	-.207	SEFABL
5	.18	.429	.184	.135	.024	2.46	.120	1.228	.028	.024	.148	AGE
6	.15	.442	.195	.136	.011	1.13	.290	1.227	.102	.112	.109	SEFEMP
7	-.08	.444	.197	.127	.002	.16	.689	1.234	-.006	.020	-.037	TCHSTD
8	-.01	.444	.198	.118	.001	.12	.736	1.240	-.050	.146	-.036	RESCRS
9	-.03	.445	.198	.107	.001	.05	.819	1.248	-.004	.020	-.035	MATANX
10	.05	.446	.199	.096	.000	.01	.922	1.256	.014	.186	.009	PRGRD
11	-.08	.446	.199	.084	.000	.00	.977	1.264	-.005	.179	.003	SEFEXP

*Constant = 2.26 (SE = 1.24)

Table 3

Multiple Regression Data For Intermediate Algebra Subjects

STEP	PEARSON R	MULT R	R SQ	ADJ R SQ	CHANGE R SQ	F CHANGE	SIGNIF. CHANGE	SE R SQ	B COEFF.*	SE B	BETA	VARIABLE NAME
1	.33	.325	.106	.093	.106	8.04	.006	1.022	.047	.022	.286	AGE
2	.25	.373	.139	.114	.034	2.62	.110.	1.014	.423	.227	.286	SEFABL
3	-.12	.415	.173	.135	.033	2.65	.108	1.002	-.269	.146	-.243	SEFEXP
4	-.12	.451	.204	.155	.031	2.53	.117	.990	-.237	.181	-.194	PRGRD
5	.04	.456	.208	.146	.004	.35	.558	.996	-.092	.129	-.089	RESCRS
6	.12	.463	.214	.139	.006	.51	.478	.999	.017	.019	-.142	MATANX
7	.17	.467	.219	.130	.004	.34	.563	1.005	.185	.212	.129	SEFEXPT
8	-.11	.471	.222	.120	.003	.25	.617	1.011	-.073	.123	-.085	TIMCRS
9	.00	.474	.225	.108	.003	.23	.635	1.017	.174	.293	.080	SEX
10	.05	.477	.227	.096	.002	.19	.668	1.024	-.043	.106	-.052	SEFEMP
11	.08	.478	.228	.082	.001	.10	.751	1.032	-.007	.023	-.046	TCHSTD

*Constant = 2.65 (SE = 1.19)

Table 4

Multiple Regression Data For Technical Mathematics Subjects

STEP	PEARSON R	MULT R	R SQ	ADJ R SQ	CHANGE R SQ	F CHANGE	SIGNIF. CHANGE	SE R SQ	B COEFF.*	SE B	BETA	VARIABLE NAME
1	.20	.202	.041	.026	.041	2.76	.101	1.628	.085	.045	.271	AGE
2	.19	.278	.077	.048	.037	2.53	.116	1.609	.314	.249	.200	SEFEXPT
3	.05	.320	.102	.060	.025	1.75	.190	1.600	.397	.248	.245	SEFEXP
4	-.15	.358	.128	.072	.026	1.86	.178	1.589	-.229	.152	-.204	SEFEMP
5	.08	.375	.141	.071	.013	.89	.349	1.591	.036	.039	.131	TCHSTD
6	-.02	.384	.147	.062	.006	.44	.509	1.598	-.010	.029	-.059	MATANX
7	.07	.392	.154	.053	.007	.46	.500	1.605	.181	.332	.101	PRGRD
8	.08	.400	.160	.044	.006	.40	.529	1.613	.107	.203	.068	RESCRS
9	-.01	.401	.160	.280	.001	.06	.812	1.627	.084	.362	-.041	SEFABL
10	-.01	.402	.161	.012	.001	.06	.815	1.640	.037	.137	.040	TIMCRS
11	.02	.402	.162	-.006	.001	.03	.863	1.655	.105	.607	.025	SEX

*Constant = -2.78 (SE = 2.45)

Table 5

Multiple Regression Data For College Algebra Subjects

STEP	PEARSON R	MULT R	R SQ	ADJ R SQ	CHANGE R SQ	F CHANGE	SIGNIF. CHANGE	SE R SQ	B COEFF.*	SE B	BETA	VARIABLE NAME
1	.49	.49	.239	.229	.239	25.4	.000	1.000	.512	.144	.430	SEFEXPT
2	-.13	.52	.272	.253	.033	3.59	.062	.985	-.193	.118	-.168	TIMCRS
3	.34	.54	.295	.268	.023	2.58	.113	.975	.030	.015	.257	MATANX
4	.15	.56	.312	.276	.017	1.93	.169	.970	.294	.238	.129	SEX
5	-.07	.57	.321	.276	.009	1.02	.316	.969	-.081	.084	-.097	SEFEMP
6	.11	.57	.326	.273	.005	.61	.436	.971	.133	.128	.111	RESCRS
7	-.08	.58	.332	.270	.006	.66	.420	.974	.082	.129	.070	SEFEXP
8	.07	.58	.336	.264	.004	.44	.508	.978	.014	.021	.076	AGE
9	.30	.58	.337	.255	.001	.12	.736	.984	-.068	.201	-.044	SEFABL
10	.21	.58	.337	.245	.001	.05	.827	.990	-.004	.021	-.023	TCHSTD
11	.16	.58	.337	.235	.001	.01	.907	.997	-.018	.154	-.013	PRGRD

*Constant = .18 (SE = 1.28)

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